

War Work of the Bureau of Standards, U.S.A.¹

THE value of science to the belligerent countries was proved over and over again during the war—in the United States no less than in other countries. The United States, however, had the advantage over other countries in this as in other matters, that, before it joined in the fighting, many lessons had been learned or, at least, were in course of being learned, and of these by no means the least was the fact that scientific workers could render enormous service to the combatant forces. We find, therefore, that, from the very moment of America's entry into the war, the services of the Bureau of Standards were made use of in connection with the many problems which arose. The volume before us is a record of some of these activities, although, as is pointed out, some of the most interesting and important of the investigations carried out cannot be described owing to military or other reasons. Moreover, at the Bureau, as at our National Physical Laboratory, a great deal of the assistance rendered took the form of oral advice and consultations, the value of which cannot be estimated, and most of which was not of a nature to become part of the permanent records. In spite of these facts, so much work was carried out that the present volume is, perforce, little more than a series of brief abstracts of the many investigations undertaken, and it is possible in a review to pick out only a few of the more interesting of these and to refer briefly to them.

It is only natural that aeronautics should occupy a prominent place in the activities of the Bureau, and the report opens with a description of the work accomplished on aeronautical instruments. Many were designed at the Bureau, where provision was made to give thorough laboratory tests to 4 per cent. of the total production of the country. These tests included experiments carried out in temperature chambers and on vibration stands, so that the instruments might be subjected to the same conditions as would be encountered in actual use.

Of very great interest is the "altitude laboratory." This consists of a concrete chamber with walls capable of withstanding a considerable pressure from without. Within this chamber the engine under test is mounted and tested under varying conditions of temperature and pressure, it being possible to reduce the latter to as low as one-third of an atmosphere—corresponding to an altitude of 35,000 ft.

Exhaustive tests on ignition systems for aeroplane engines were also carried out, the majority on the sparking-plugs—or spark-plugs, as the Americans term them. The conditions to which these plugs are subjected in aero-engines are much more severe than in ordinary motor-car practice. The pressure inside the cylinders may amount to

600 lb. per square inch, and during operation the sparking-plug is exposed alternately to a blast of air which may be at a temperature well below zero, and to a flame of burning petrol, the temperature of which is estimated at 2500° C. As a result of research, several porcelains have been obtained, which have high electrical resistance and mechanical strength while hot, and are capable of withstanding sudden temperature changes; they have been largely used in the manufacture of sparking-plugs in the States. In addition to the work on the insulating material of the plugs, brittleness occurring in nickel electrodes has been investigated, and cements for fixing the electrode in the insulator have been studied.

A delightfully simple form of gauge for measuring the tension of aeroplane wires was designed at the Bureau. The wire is supported on two pins at a known distance apart, and loaded, by means of hand levers, at the middle of the span thus formed. The load is measured by means of one Ames dial, and the deflection of the wire by another. The dials are calibrated so that it is possible to read off the tension directly when the wire is deflected 0.1 in.

Reference must also be made to the work on dopes for aeroplane fabrics. These may be divided into two classes, cellulose nitrate dopes and cellulose acetate dopes. The former are highly inflammable, and therefore undesirable. Before the war America obtained all her cellulose acetate from the Bayer Company of Germany, and it was not until after seven months of war that provision was made for securing an adequate supply of raw material. In the meantime, the United States had been reduced to such devices as obtaining cuttings and scraps of kinema films in order to manufacture sufficient quantities of dope.

Leaving the aeronautical side of the report, and turning to the section headed "Gauges" (or rather "Gages"), one is impressed with the small amount of work done at the Bureau compared with what was done at the National Physical Laboratory. It appears that the total number of gauges tested at the Bureau and its branch laboratories was 60,000. This is about the average number tested in two months between 1915 and 1918 at the National Physical Laboratory, and about the average in six weeks during 1917–18.

Very interesting reading is furnished by the section on invisible signalling. In this connection a number of experiments were made, using both ultra-violet and infra-red radiations. It was found that the former were liable to fail owing to a fluorescence which was produced in the eye of the enemy observer—particularly if he were young. Infra-red rays, on the other hand, gave more promising results, but, as no methods are known for detecting them unless one is in the direct line of "sight," it is a moot question whether the method should be developed further.

It may seem a far cry from the study of ultra-

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violet light for the purposes of invisible signalling to the investigation of sole leather for boots, but the report being arranged alphabetically, they come in close proximity therein. Perhaps this is well, for it indicates the widespread activities of the Bureau. Not only were the wearing properties of various soles, made of both leather and composition, tested, but a radiographic study of the clinching of the nails used in repairing the soles was also undertaken.

The work of the metallurgical department ranged between such widely different problems as the investigation of nails for horse-shoes and the study of gold-palladium alloys as substitutes for platinum. As is to be expected, the study of light (aluminium) alloys, largely in connection with aircraft requirements, occupies a prominent place. It is stated that the work to date has shown the superiority of alloys containing either copper and zinc or magnesium and copper as additions to aluminium, and it is of interest to note that the Bureau concentrated on magnesium-copper-aluminium alloys because the National Physical Laboratory was, at the time, investigating copper-zinc-aluminium alloys. In connection with these materials attention must be directed to the curious phrase referring to "the French alloy Duralumin," while later Wilm is correctly referred to as the discoverer of the hardening of this alloy after heat treatment.

Another use to which an aluminium alloy was put was for the manufacture of mirrors of high reflecting power, it being found that the compound Al_3Mg_4 , containing 50 per cent. of magnesium, gave a reflection of 85 per cent. in the blue and 93 per cent. in the red portions of the spectrum, though such mirrors are not recommended where permanency is of prime importance. It may be of interest to note that the recent work of Hanson and Gayler, at the National Physical

Laboratory, throws considerable doubt on the existence of this compound.

Amongst the many other metallurgical researches undertaken, two may be selected for mention; one is an investigation on the welding of steel, and the other a series of tests on different compositions of bearing metals.

The production and testing of optical glass are other branches of the activities of the Bureau which call for special mention. The manufacture was commenced in 1914-15—before America declared war—and in 1917 a large furnace holding a 1000-lb. pot was built, in which glass was produced on a commercial scale, and very satisfactory results were obtained.

Brief reference only can be made to other investigations described in the report. The photographic work, especially illustrating a view taken from an aeroplane through a haze, (1) on an ordinary plate, and (2) on a plate specially prepared at the Bureau, is of great interest. A very large amount of work on radio-communication, including special investigations on direction-finding and on signalling from submerged submarines, is also described. Investigations on rubber for tyres, insulated wire, etc., and work on sound-ranging and on sound transmitted through the earth, which was a development of British and French methods, also deserve mention. Work on textiles covers a very wide range of subjects, including some research on dye-stuff chemistry. Finally, there is the work on X-rays, which, however, was not initiated until 1917.

The Bureau of Standards is to be congratulated, not only on the immense amount of useful war work which it has carried out, but also on the interesting manner in which it has presented the summary of this work to the public.

J. L. H.

Obituary.

THE RIGHT HON. LORD LINDLEY, P.C., F.R.S.
THE name of the Right Hon. Lord Lindley, whose death, in his ninety-fourth year, occurred at East Carlton, Norwich, on December 9, will long be remembered as that of a distinguished lawyer and a great judge. The features in Lord Lindley's judgments which arrested attention were themselves due to the remarkable scientific instinct with which they were imbued. This quality may have been inherited, for the same independence and sagacity, displayed in another sphere, mark the writings of Lord Lindley's father, Dr. John Lindley, F.R.S., professor of botany at University College, and for many years the editor and principal proprietor of the *Gardeners' Chronicle*.

The constant intercourse between Prof. Lindley and Sir William Hooker, director of Kew during 1841-65, brought young Lindley into contact with Dr. (afterwards Sir Joseph) Hooker, assistant director of Kew from 1855, and Sir William's successor in the directorship during 1865-85. The fast

friendship and constant correspondence thus initiated ended only with the death of Sir Joseph in 1911. This correspondence, it is fair to state, rarely related to technical botanical subjects. On the contrary, it indicates rather that Lindley and Hooker, who often consulted each other on important matters of business, each placed implicit reliance on the judgment of the other as to questions which concerned their own particular activities. But while it is doubtless true that the keen interest which Lord Lindley, throughout his long life, took in botanical pursuits was strengthened by his friendly relationship with Sir Joseph Hooker, it is unquestionable that it had its foundation in his admiration for, and sympathy with, his father's work. His interest led to intimate intercourse with other prominent contemporary botanists, notably with the late Mr. George Bentham, joint-author with Sir Joseph Hooker of that remarkable work, the "*Genera Plantarum*."

Equally keen throughout his life was the sym-